WWW.IJRPR.COM

**International Journal of Research Publication and Reviews**

Journal homepage: www.ijrpr.com ISSN 2582-7421

# A Review Paper on Replacement of Cement with Silica Fume, Wheat Straw Ash and Steel Fibers in Concrete

***Rambabu Patidar[1], Rahul Sharma[2]***

[1]M Tech Student, Department of Structural Design, Prashanti Institute of Technology and Science Ujjain, India
[2]Professor, Department of Structural Design, Prashanti Institute of Technology and Science Ujjain, India

**ABSTRACT**

Concrete is the most widespread man-made building material used for various civil structures purpose. Different types of experiments carried out on concrete every day to improve properties concrete. Different types of cement materials are used to modify the properties of concrete it is used with an admixture. The main advantage of using cement material for construction is reduces cement consumption and improves concrete properties. Among all cementitious materials Silica fume and wheat straw ash provides the best strength and strength Durability of concrete. The use of fibers together with cementitious material in concrete is not new, but there is a change in type fibers that is used in concrete. The main advantages of using fibers with cementitious material the fibers in the concrete are properly distributed. In this research, a combination of different types steel fibers along with silica and wheat straw ash are studied for strength concrete. Silica fume percentages of 5%, 7.5% and 10% were used in this experiment. The percentage of wheat straw ash was 5% and steel fiber was 1%.

This paper represents the most comprehensive research to date in the field of mechanical, physical and properties of concrete related to durability. In general, the addition of fibers together with silica and Wheat straw ash in concrete has been proven to improve mechanical properties concrete, especially tensile strength and ductility. A total of 54 mixtures (test mixture, control mixture and variation mixture) were prepared in this research work. M30 concrete, cubes and cylinders were cast, cube size 150mmX150mmX150mmand cylinders 150 mm in diameter and 300 mm in height were cast and pressure tested strength and Split tensile strength at the age of 7 days and 28 days. Based on the results Silica fume, wheat straw ash, and steel fiber reinforced concrete have all been found to increase the strength and durability of variation mix concrete at all ages compared to normal concrete. It isit is used for better performance as well as environmental sustainability.

**Keywords**: -: Compressive Strength, Flexural Strength, Aspect Ratio, Steel fibers, cementitious material, Silica Fume, Wheat Straw Ash, Mechanical properties of concrete.

## INTRODUCTION

Nowadays, concrete is the most widespread and most important building material used. Traditionally, it consists of coarse aggregate, fine aggregate, cement and water. Along with this admixture, minerals and admixtures were used in the concrete. Concrete can be defined as ordinary concrete, standard concrete and high strength concrete based on its characteristic compressive strength. Concrete is a modern building material that is used for all types of construction. The use of concrete is very high in every construction. Whenever a structure is built, the main priority is to make the structure safe and strong. Also, the main criterion is to design the structure economically. Cement is the main binder in concrete, which ensures the strength and durability of concrete. Today, concrete is modified with various materials whose main job is to give the concrete more resistance and strength, such materials being wheat straw fly ash, silica fume and steel fibers. These are the materials that help the concrete work in the desired order. In order to make the concrete stronger in all aspects, it is very necessary to modify the concrete in a different and more advanced way. Steel fibers are one of the components that give concrete greater strength and durability. High-performance concrete can be made by adding silica fume as a partial replacement for cement. The combined use of wheat straw ash, silica fume and steel fibers improves the mechanical properties of concrete. In India and many other countries, farmers burn it, contributing to air pollution and posing a risk to public health. Wheat straw waste is a major agricultural by-product obtained from cereal production that causes environmental pollution as farmer's burn it directly in open fields. When wheat straw waste is properly incinerated under controlled conditions, it provides cementitious properties that can be used as a supplementary cementitious material. The resulting fly ash contains a higher percentage of silica, the fly ash particles are also finer than cement and is therefore considered a supplementary cementitious material. The advantage of using wheat straw ash in concrete as a cement replacement material revealed an increase in compressive strength when it was replaced with 5% cement. Researchers continue to investigate the durability aspects of concrete using wheat straw ash as a replacement material, as durability is one of the important properties of any type of concrete. Durability was found to be improved due to the pozzolanic properties of wheat straw ash and its filler in cement concrete. In addition, researchers also use wheat straw ash as a filler material in concrete due to the fineness of the particles. The compressive strength of concrete is increased by fine aggregate, which has been replaced by wheat straw ash. Silica Fume is a by-product of the electric arc furnace used in the production of silicon metal and silicon alloy. Silica fumes help improve both the mechanical properties and durability of concrete. In these decades, economic consideration and consideration for the environment are very important for all types of construction. Studies show that up to 20% replacement of wheat straw ash in

OPC is valuable in terms of strength and durability. The addition of fibers to concrete results in a dense and uniform material, it also helps to improve the microstructure and control microcracks in the concrete. In general, the addition of fibers along with silica fume and wheat straw fly ash to concrete has been shown to improve the mechanical properties of concrete, especially tensile strength and ductility.

## LITERATURE REVIEW

**Gurpreet Singh (2020):** Current research is based on strength and durability analysis of concrete structures. In this case, modified concrete is made by adding a proportion (by weight) of cement and silica fume. Research has shown that steel fibers are an excellent material with reinforcing properties that help reduce matrix. This is why we improve concrete structures. Therefore, due to structural and durability requirements, it was decided to reinforce the standard cement concrete with a certain percentage of steel fibers. Mechanical properties such as compressive strength, split tensile strength, flexural strength, and durability properties such as water absorption were tested on lots formulated for healing and the results were compared to those of the control combination.

**A.S. Santi et al. (2011):** Published a paper on research on strength development of high-strength concrete containing straw ash and silica fume. In this paper, results of an experimental study on compressive strength of high-strength concrete are presented. Part of the cement in high-strength concrete is replaced with straw ash (FA) and silica fume (SF). In this study, class C straw ash was used at various amounts of 30%, 40% and 50% of cement, and silica fume was used at 6% and 10% by weight of cement. The concrete mix ratio was a constant water-to-binder ratio of 0.4, with fluidizers added according to the level of workability required. The total binder content per cubic meter was 450 kg. Concrete samples were cured at room temperature using standard wet-curing methods. Compressive strength was measured at various ages up to 90 days. The addition of 6% silica fume to various straw ash substitutes gives higher compressive strength than 10% silica fume. High strength concrete is obtained with 6% silica fume and 40% straw ash.

**Roy & Sil (2012):** Investigating the effects of partial replacement of cement by silica fume on hardened concrete. The maximum compressive strength (for both cubes and cylinders) is found at 10% replacement of cement with silica fume, which is higher than normal concrete for cubes and cylinders) (19.6% and 16.82% respectively)). The strength and flexural strength of fumed concrete (3.61N/mm2 and 4.93 N/mm2, respectively) increased by about 38.58% and 21.13%, respectively, compared to normal concrete (M50).

**Suthar Sunil B, B.K. Shah (2013):** Published paper on research into strength development of high performance concrete using Alccofine and fly ash. In this paper, results of an experimental study on compressive strength of high-strength concrete are presented. Alcofine and fly ash are used to partially replace cement in high-strength concrete. In this study, he used class F straw ash in varying proportions of 20, 25, 30, and 35 percent, and alcofine in his 4, 6, 8, 10, 12, and 14 weight percent of cement. used in proportion. The concrete mix ratio was a constant water-to-binder ratio of 0.4, with fluidizers added according to the level of workability required. Concrete samples were cured at room temperature using standard wet-curing methods. Compressive strength was measured after 56 days. His 3-component blend of 7% Alkcofin and 25% wheat straw ash gives higher results compared to his 2-component blends individually.

**Kumar A. et al. (2015):** A research paper on the partial replacement of cement in M-30 grade concrete with silica fume and straw ash was investigated. Partial replacement of cement in M-30 concrete with silica fume and straw ash is the subject of research. Silica fume was used in place of OPC at 0%, 2.5%, 5% and 7.5%, and straw ash was used in place of regular Portland cement at 0%, 5%, 10% and 15% by weight. rice field. All test samples contained 1% superplasticizer to improve workability at lower water-cement ratios and to confirm the significant effect of silica fume and straw ash on concrete properties was In all cases, the water-to-cement ratio was set at 0.43.The highest compressive strength of 43.1 N/mm2 was achieved with a cement with an alternative content of 7.5 wt% SF and 20 wt% FA. 6.47 N/mm2 was the maximum bending strength obtained when replacing 7.5 wt% SF and 20 wt% FA with cement. 2.573 N/mm2 was the maximum breaking strength achieved for cement with alternate content of 7.5 wt% SF and 20 wt% FA.

**Irfan Ali Shah et al. (2019):** Lecture on the use of straw ash as a cement substitute for concrete. In this study, straw ash, an agricultural waste, is used as a cement substitute material. Cement replacement rates are 0%, 5%, 10%, 15% and 20%. A total of 45 cubic specimens were cast, cured and evaluated at curing times of 7, 28 and 90 days to assess the compressive strength of concrete. The results show that the maximum compressive strength with 10% cement replacement is 40 N/mm2 after 28 days and the minimum strength with 20% cement replacement is 34 N/mm2 after 28 days.

**Muhammad Shoaib Khan et al. (2019):** Lecture on investigating the properties of wheat straw ash as a partial cement substitute in the production of ready-mixed concrete. In this study, to determine the optimal proportion of WSA as a partial cement replacement, he conducted a series of tests with his WSA replacements of 10%, 20%, and 30% by weight of cement. Due to the high water absorption of ash, slump and compression modulus tests show that workability decreases with increasing ash content. One of the most important results is WSA's high water absorption capacity, which prevents concrete from shrinking over time. The results show that the strength of concrete decreases as the proportion of WSA in concrete increases.Conventional concrete was comparable to a 10% substitute. A reduction in strength is observed at 20% and 30% replacement of cement by WSA.M.D.

**Ikramullah Khan, G. Swamy Yadav, S. Haripriya Varma (2020):** This experiment is done to find out the mechanical behavior of concrete by adding fiber at a range 0.02%, 0.04%, 0.06%, 0.08% and 0.1% by weight of cement and wheat straw ash partially replaced with cement by 10% by weight of cement. The results which are found were then compared with M35 grade normal concrete. The results were found that when compared to normal concrete, the wheat straw ash binds the concrete mix to make it dense.

**Poojari Yugendar, Kampilla Vishnu (2020):** In this paper, strength behavior of concrete with different percentage of wheat straw ash and fiber were studied. This experiment is done to find out the workability, Compressive strength and split tensile strength of concrete. Wheat straw ash used as 0%,

5%, 10%, 15% and 20% in weight basis. And also fiber proportion was used as 0%, 0.5%, 1.0%, 1.5% and 2.0%. The testing results showed that, as the steel fiber content increases, Compressive strength and split tensile strength was observed to be increased up to 1.0% and then decreased. It is found that the workability of concrete decreases as the fiber content increases. Investigation was done to know the effect of wheat straw ash and fiber on Compressive strength of concrete of concrete. The analysis shows that, steel fibers and wheat straw ash content effects the strength of concrete.

**Piotr Smarzewski (2019):** The main purposes of this study is to determine the fracture energy of high performance concrete (HPC) which is containing silica fume (SF). This article presents the research on changes of the mechanical properties including Compressive strength of concrete, splitting tensile strength of concrete, modulus of elasticity of concrete, fracture energy, and characteristic length of six high performance concrete, performed by the addition of silica fume. Percentages additions of silica fume were 0%, 5%, 10%, 15%, 20% and 25% by mass of cement. The water/binder ratio was 0.25. The use of silica fume plays an important role in increases in mechanical properties of concrete. This study indicates that the mechanical properties of HPC were improved to a great extent at 28 days when cement used in concrete was replaced by silica fume. 10% replacement of cement with silica fume results in a 26% increase in tensile splitting strength, and a 13% increment in compression strength of concrete. The results suggested that silica fume can effectively replaced by cement. it is concludes that the replacement of silica fume with cement should not more than 10%.

**Mr. Omprakash Devenda, Mr. Ramanuj Jaldhari (2019):** In this work evaluate the performance of concrete with silica fume and also replaces cement by steel fiber. In this study silica fume has been replaced in ordinary Portland cement(43 Grade) cement, with different percentages 2.5%, 5%,7.5% and 10% and also steel fiber replaced with cement which varies 2.5% to 10% by weight of cement. A total 24 mixes (trial mix, control mix and variation mix) were prepared for M-35 concrete & M-40 of concrete. In this study examine the performance of Cube Compressive strength for 7 days and 28 days, Beam Flexural strength 28 days and Cylinder Splitting tensile strength for 28 days respectively. Total number cubes specimen140, cylinders 60 and beams 60, which were cast for influence of silica fume and steel fiber on concrete. These Concrete cubes, beams, cylinders specimens were cured in water. On the basis of result that silica fume and steel fiber concrete was found to increase in all strength and durability of variation mix of concrete on all age when compared to normal concrete.

**Amit, Akash batra, Pappu Sharma, (2019):** This research represents the effect of silica fume and steel fibers on normal concrete and will also help in results. In this research, Experimental investigations and analysis of results were done to study the Compressive strength and flexural behavior of concrete with different percentage of silica fume and steel fibers. The concrete mix of M40 were adopted with varying percentage of the silica fume from 0%, 5%, 10%, 15% & 20% in the replacement of cement weight and stainless steel fibers of diameter and length 0.50 mm and 40 mm respectively with the aspect ratio 80 at various percentages of 0%, 0.4%, 1.4%, 2.4% & 3.4% by weight of the cement were adopted. On the basis of results it shows that adding silica fume and steel fibers in concrete help in improving strength and durability of concrete.

**Prakash, Maneeth P D, Dr.ShreenivasReddy S (2018):** In this work hybrid fiber concrete were casted by replacing cement with wheat straw ash by 25% 30% and 35% and 5%, 10% and 15% of silica fume. A percentage of 0.5% Steel and 0.5% polypropylene fiber are used for all three mixes. The density of concrete increases by adding micro silica and steel fiber to concrete which improves the strength of concrete, Compressive strength, Split tensile and flexural strength of HFRC of mix-2 increases. The steel fiber results increases in tensile strength of concrete. The use of silica fume is also recommended for mass concrete work.

**Miss Akshata A Mulgund, Dr dilip k kulkarni (2018):** Current research has been done on concrete due to the effect of silica fume with steel fibers outside and outside the Portland pozzolana cement. In this study the concrete mix with 20% silica fume, with the inclusion of steel rods of 0.5mm diameter and 60 cm, by various percentages such as 0%, 0.5%, 1.0% and 1.5%, 2.0% concrete volume in M 30 grade concrete. The effect of mixing minerals (silica smoke) such as cement and non-ferrous metals in machine structures was analyzed and compared with conventional concrete. In comparison, with standard concrete the return of 20% cement by silica fire showed a 6%, 8.5% and 10.75 increases in Compressive strength within 28 days of treatment.

**Suhail Rashid Dar and Er Ankit Mahajan (2018):** In this research a total of 90 samples have been cast in which 30 was cubes with 150mm x150mm x150mm dimensions, 30 were beams of dimensions 500mm x100mm x 100mm and 30 were cylinders of 150mm diameter and 300mm height used for experiments. On the basis of present investigation it shows that, replacement of cement with silica fume up to 10% and steel fiber 0.5% by weight of cement in concrete, increases the Compressive strength, splitting tensile strength, flexural strength of concrete up to:

Compressive strength increases by 3% - 5%.

Flexural Strength increases by 5% - 10%.

**S. Mahmoud Motahari Karein, A. Ramezanianpour, Taghi Ebadi (2017):** In this study, the density of silica fume was increased by producing silica fume granules mixed with a solid super plasticizer. The effects of silica fume on durability of concrete and as well as on mechanical properties of concrete were tested. Results show that, there is increase in strength and surface electrical resistivity, and a decrease in permeability for both silica fume and granular, compared to the control sample.

**P.Prathap, T.Naresh kumar, Dr.S.M.V Narayana (2017):** This investigation carried out on concrete due to the effect of silica fume with and without steel fibers on 53-Grade Portland cement. In this study concrete mixes with silica fume of different percentage at 0%, 5%, 10% and 15% by the weight of cement for M-35 grade of concrete. The optimum use of silica fume which give maximum Compressive strength were found to be 10%. Adding steel fibers of diameter 0.5mm and length 12mm with aspect ratio 24, at the various percentages as 0.2%, 0.4%, 0.8%, 1.0% and 2%. The effects of mineral admixture as cement replacement material with and without steel fibers on mechanical properties were studies and compared with convectional concrete. The Compressive strength increases due to the addition of silica fume compared with convectional concrete. The maximum increases in Compressive strength were upto10% at the age 28 days. The Compressive strength increases when steel fiber added for the optimum content of silica fume up to at 28 days. The Split tensile strength of concrete also increases significantly due to the addition of steel fibers at 28 days. The flexural strength of concrete increases significantly due to the addition of steel fibers at the age of 28 days.

## CONCLUSION

On the basis of experiments, it concludes that replacement of cement with Silica Fume, Wheat Straw Ash and Steel Fibers the Compressive strength as well as tensile strength of concrete increases. The following are the conclusions are found from this study as below.

1. In this research it is found that, the optimum percentage of Silica Fume, Wheat Straw Ash and Steel Fibers is found to be 7.5%, 5% and 1%.
2. Addition of silica fume in concrete reduces workability and increases bond strength of concrete.
3. Silica fume increases Compressive strength of concrete significantly, but the increment depends upon amount of silica fume which is replaced by cement.
4. Addition of silica fume, steel fibers in concrete it increases the density of concrete which helps in improvement of strength.
5. Addition of Wheat straw ash in concrete further reduces workability.
6. The optimum level of wheat straw ash is 5%, in order to obtain maximum strength of concrete.
7. Apart from economical point of view, it is observed that, replacement of cement with wheat straw ash, silica fume and steel fibers can be economical & environmental friendly for mass concrete work. It will not only reduce the consumption of cement, which will be eco-friendly but will also solve the problems of disposal of wheat straw ash.

**RFERENCES**


1. Amit, Akash batra, Pappu Sharma, Sohan lal. “Impact of Concrete by Using Steel Fibers and Silica Fume as Partial Substitute of Cement.” International Research Journal of Engineering and Technology (IRJET).Volume: 06 Issue: 03 | Mar 2019,, ISSN: 2395-0056.
2. Gurpreet Singh. “Study on Collective effect of Silica Fume and Steel Fiber on Strength and Durability properties of Concrete.” ELSEVIER July 2020.
3. Miss Akshata A Mulgund, Dr Dilip K Kulkarni. “Comparative Study of Combined Effect of Silica Fume and Steel Fibers Reinforced Concrete Over Conventional Concrete.” International Journal of Emerging Trends in Engineering and Development Issue 8, Vol.4 (June-July 2018).
4. Mehmet Gesog, Erhan Güneyisi, Radhwan Alzeebaree, Kasım Mermerdas “Effect of silica fume and steel fiber on the mechanical properties of the concretes produced with cold bonded fly ash aggregates.” ELSEVIER Received 4 July 2012.
5. Mr. Omprakash Devenda1, Mr. Ramanuj Jaldhari2 “To study the affect of silica fume and steel fibers on strength of concrete by partial replacement of cement.” International Journal of resent trends in engineering and research ISSN 2455-1457 year 2019.
6. P. Prathap, T. Naresh kumar, Dr. S.M.V Narayana. “Evaluation of Mechanical Properties of Concrete using Silica fume and Steel Fibers.” International Journal of Scientific & Engineering Research Volume 8, Issue 5, May-2017 ISSN 2229-5518.
7. Prakash, Maneeth P D, Dr.ShreenivasReddy S, Brijbhushan S, Siddharth B. “Effect Of Fly Ash And Micro Silica On Hybrid Fiber Reinforced Concrete.” JETIR June 2018, Volume 5, Issue 6, (ISSN-2349-5162).
8. Rahul Dogra, Ankit. “Effect of Silica Fume on Various Properties of Fiber Reinforced Concrete.” International Journal of Civil Engineering and Technology (IJCIET) Volume 7, Issue 4, July-August 2016, pp. 542–548, ISSN -0976-6316.
9. S Yeshwanthi Roy, K Thiagarajan and N Uma maheswari “Experimental study on mechanical properties of modified concrete prepared with M-sand, Silica fume and Steel fiber” IOP Conference Series: Materials Science and Engineering 2019.
10. S. Arivalagan “Flexural behavior of hybrid fiber (steel fiber and silica fume) reinforced self compacting composite concrete members.”World Journal of Engineering Vol. 11 Issue: 4, pp.323-330.
11. Suseela Alla a,, M. Jayaram b, S.S. Asadi a “An experimental investigation for replacements of river sand and cement with Robo-sand, fly-ash and silica fume in concrete to evaluate the influence in durability properties.” ELSEVIER Received 20 May 2020.
12. Suhail Rashid Dar, Er Ankit Mahajan. “Effect of Silica Fume and Steel Fibers In Concrete.”International Journal of Civil Engineering and Technology (IJCIET) Volume 9, Issue 7, July 2018, pp. 1950–195, ISSN: 0976-6316.
13. T.H. Sadashiva Murthy. “Split Tensile Strength of Steel Fiber Reinforced Concrete with Fly Ash and Silica Fume as Binary and Ternary Blends under Chloride Curing.” International Journal of Civil Engineering Research. ISSN 2278-3652 Volume 5, Number 4 (2014), pp. 379-384.
14. Al-Akhras N.M., Abu-Alfoul B.A. (2002) “Effect of wheat straw ash on mechanical properties of autoclaved mortar” – journal of Cement and Concrete Research 32 (2002) 859–86.